

I – Problem Statement Title (04-GS120)

Development of Specifications to Minimize Construction Induced Ground Vibration Damage to Nearby Structures

II – Research Problem Statement

Question: How can we assess the effects of construction induced vibrations and develop mitigation measures to minimize the effects of construction activities such as pile driving, vibratory earthwork compaction, etc. on adjacent buildings and other structures?

Develop specific guidelines for assessing the ground and structure vibration magnitudes and predominant frequencies, proper mitigating methods to prevent damage to adjacent sensitive facilities both above and below the grade, and sharing the responsibility among the owner, designer, and contractor. The lack of a guideline or specification for this problem has resulted in variable degree of damage to sensitive structures located near construction site depending on the characteristics of the ground vibration caused by the nearby construction activities.

III – Objective

The objective of this research is to develop guidelines or specifications including methods to estimate the ground and structure vibration levels for currently used pile driving and vibratory earthwork compaction practices in Highway Transportation (HT) construction projects and to prevent damages to adjacent sensitive facilities above and below grades. These guidelines should be established based on the current state-of-the-art knowledge on this subject and new theoretical and in-situ experimental investigations. Additionally, the application of the guidelines should be illustrated by examples or other classification methods for all ranges of pile driving and earthwork currently used in the HT practice and take into account the subsurface soil conditions at the site.

IV – Background

Severe public discomfort and property damages due to induced ground vibration by construction projects are common problem for construction, which involves use of pile driving, and heavy vibratory earthwork compaction in urban area. US Bureau of Mines and European codes have developed criteria for damages assessment based on the ground peak particle velocity (PPV) and frequency of the ground vibration induced mostly by blasting. The PPV can be measured at the desired location on the ground by commercially available sensors and data logging equipment. There are also vibration energy-attenuation relationship established by various authors in terms of the energy delivered and the distance from the impact location. However, this information can not be used because they do not include the effects of the following important parameters:

- Pile driving methods, hammer types, rates of hammer strikes, etc,
- Vibratory earthwork compaction equipment types and compacting behavior,

- Subsurface soil and groundwater conditions,
- Foundation support types; spread footing, piers, slab on grade, pile support, etc,
- Building type and its vibration characteristics,
- Underground utilities structural and vibration characteristics, depth, presence of sleeve pipes, end restraints, etc,
- Definition of the damages of concern and classification and quantifying the extent of the damage in relation with other parameters.

V – Statement of Urgency and Benefits

A. Support of the Department’s Mission/Goals:

(Improving Mobility: Safety, Reliability and Productivity)

Guidelines or construction specifications for the ground vibration assessment and mitigation methods to minimize damage to existing structures adjacent to construction activities are required for all CT construction projects that involve use of heavy pile driving and compaction machinery.

B. Return on Investment:

Addressing this problem will result in minimizing construction impact on the surrounding communities, potential damage to private and public properties, save money for the state, and eliminated unnecessary tensions on both contractor and Caltrans project team member.

VI – Related Research

- Edward L, Hajduk et all (2004), *Pile Driving Vibration Energy-Attenuation Relationships in Charleston, SC Area* (2004), 5th Int. Conf. On Case Histories, NY.
- OGDW field Support for Maxwell Br. (June 2004), *Vibration Monitoring and Mitigation for Pile Driving Near 58-in Napa District Sanitary Pipe*.
- Wiss, J. F. (1981), *Construction Vibrations, State of Art*, J. of Geotech Div., ASCE, V. 107.

VII – Deployment Potential

As a result of this research, guidelines for assessment of ground and structure vibration due to nearby pile driving and earthwork compaction activities and practical mitigation methods to prevent structural or buried utilities damage will be developed. These specifications will minimize construction impact on the surrounding communities, potential damage to private and public properties, save money for the state, and eliminate unnecessary tensions on both contractor and Caltrans project team member.